1995
Executive Research Project
S3

Military Man in Space Essential to National Strategy

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY N/A	3. DISTRIBUTION/AVAILABILITY OF REPORT Distribution Statement A: Approved for Public Release: distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NDU-ICAF-95-S3	5. MONITORING ORGANIZATION REPORT NUMBER(S) N/A
6a. NAME OF PERFORMING ORGANIZATION Industrial College of the Armed Forces 6b. OFFICE SYMBOL (If applicable) ICAF-AR	7a. NAME OF MONITORING ORGANIZATION National Defense University
6c. ADDRESS (City, State, and ZIP Code) Fort McNair Washington, D.C. 20319-6000	7b. ADDRESS (City, State, and ZIP Code) NDU-LD-SCH Ft. McNair Washington, D.C. 20319-6000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION N/A 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER N/A
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)

Military Man in Space - Essential to National Security

12. PERSONAL AUTHOR(S) Joseph A. Carretto, Jr

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Research	FROM Aug 94 TO Apr 95	1995 April	62

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

See Attached

DTIC QUALITY INSPECTED 5

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Susan Lemke or Tina Lavato	22b. TELEPHONE (Include Area Code) (202) 287-9458 22c. OFFICE SYMBOL NDU-LD-SCH

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

Abstract

Military Man in Space
Essential to National Strategy

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The United States has never had a consistent policy regarding the use of military men and women in space. At a time when the United States, and much of the developed world, has become critically dependent on space assets, continued inconsistency may prove detrimental. This paper presents the case that using military "Soldiers" in space is important to the national security of the United States.

The paper begins with a review of how space systems impact national policy today, and how that might change over the next few decades. Subsequent chapters focus on unique talents humans bring to space operations, citing case histories where astronauts and cosmonauts made the difference between mission success or failure. Following that is a history of previous military programs designed to use - or explore the use of - military astronauts. Despite the cancellation of those programs, there are still potential jobs for military man in space, and they are discussed as well.

Inconsistency in the military space program may be the result of a space doctrine that is different from air, land, or sea doctrine. Possible reasons are discussed, but the point is made that the doctrine should be the same - space is another battlefield arena like air, land and sea. As space becomes even more vital to the political and economic well being of this country, the need for military involvement increases. With the various space efforts already under way, there is a natural, cost-effective way for the military to develop a manned space program. The final section of the paper presents a framework to establish such a program.

DISCLAIMER

This research report represents the views of the author and does not necessarily reflect the official opinion of the Industrial College of the Armed Forces, the National Defense University, or the Department of Defense.

> Personally, I find it easier to visualize a long-run military future in space built around manned vehicles rather than unmanned. Under a treaty of disarmament, I can picture manned craft used for inspection and surveillance, displaying greater versatility and selectivity in data-gathering than a purely automatic system. In a time of cold war, I can see manned craft as less provocative and less subject to interference by a space rival. . . . I view future manned ships, particularly effective in deep space, as more likely to outsmart and outplay purely automatic systems.[1]

INTRODUCTION

The United States of America, and much of the developed world, has become critically dependent on space assets. The latest national security strategy, signed by President Clinton in February 1995, specifically calls for "maintaining the U.S. position as the major economic, political, military, and technological power in space."[2] For communications, surveillance, navigation, and a host of other applications, space has become an indispensable arena for operations. General Thomas Moorman, former commander of Air Force Space Command and now USAF's Vice Chief of Staff, is one of this country's strongest advocates of space systems: "We're going to be all the more dependent on space systems for global support in the 1990's. They will become increasingly important as force-multipliers."[3] Space operations have been incorporated into the basic doctrine of all the armed forces. The Air Force even emphasized space by entitling its latest version "Basic Aerospace Doctrine of the United States Air Force," and filled it with references to space support, space control, spacelift, and counter space activities.[4] Yet with all the importance we now place on space for both military and non-military activities, with all the years of history and volumes of doctrine putting men and woman at the heart of our military activities, this country has no plans for employing military men and women in the "high ground" of space. The way we operate in space today does not require the presence of military members in orbit. But a national strategy is shortsighted if it considers only the

present situation. Space is already a key part of our national strategy, and space operations are becoming more important to our national survival and growth. It is appropriate to examine the role military men and women can have, and *should* have, in exploiting our national goals in the increasingly critical arena of space.[a] Naturally, this comes with additional cost, and additional risk, and it's appropriate to include that in this assessment.

This paper presents arguments for incorporating manned military activities into our space strategy. It begins with a review of how space systems impact national policy today, and how that might change over the next few decades. Subsequent chapters focus on unique talents humans bring to space operations, and how those talents can pave the path to enhanced capabilities in space. I will show how, and why, the manned military space program, like its counterpart air, land and sea programs, *must* be an integral part of the complete national strategy of the United States. I'll conclude with a framework to build the infrastructure by which military men and women can serve our national strategic objectives in space with the same capability we now rely upon in the air, on land, and at sea.

Space is more than a mission, more than a field of operations. It is, to borrow the famous "Star Trek" phrase, "the final frontier." It is also the final battlefield. In the past, military members have always defended the frontier and controlled the battlefield. The future can be no different. Our national interests depend on it.

> Tomorrow's national military strategy must fundamentally accept that potential adversaries with the capabilities to do so will conduct military hostilities beyond the terrestrial arena, and into the limits of space. This could profoundly influence the course and outcome of conflict on land, at sea and in the air.
>
> - General Charles Horner, USAF

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[a] Clearly military men and women are involved in current space activities. Many of the astronauts flying on the Space Shuttle are military officers; however, they are assigned to NASA and not serving in a military capacity. Most of them never return to military duty.

USING SPACE TODAY

Space is no longer the realm of fantasy. What was once so incredible as to be the sole province of science fiction is now so prevalent it goes unnoticed. The television we watch every day is relayed over satellites far above the earth. No news broadcast is complete without satellite weather photos. Airplanes, trucks, and even some automobiles now find their way along the earth's surface with precise navigation signals transmitted from a constellation of Global Positioning System (GPS) satellites. Images from space help scientists locate natural resources and assess devastation from natural disasters. For over two decades national command authorities have relied exclusively upon sentinels in space to provide warning of nuclear attack, and to relay the critical instructions needed to respond should one occur. Space has become an integral part of our everyday lives. Not only in the services it provides, as exemplified above, but as a tool of our government for conducting national affairs. It is a critical part of today's national strategy.

Almost everyone today recognizes space systems as military instruments of government power. If there was any doubt before, the Gulf War of 1991 proved that space systems provide a vital part of the military capability of the United States. Former Secretary of Defense Les Aspin declared that "The Persian Gulf conflict of 1991 and other recent contingencies demonstrated that space forces are fundamental to fighting and decisively winning wars."[5] Precise navigation allowed planes to bomb key targets with pinpoint precision, and foot soldiers to find their way over featureless deserts. The entire communication network was built around satellite relays and ground stations. Even the *absence* of space assets proved pivotal to the war: Iraq's lack of satellite imagery allowed the U.S. commander to plan and execute the "left hook" with little fear

of compromise. As Gen. Schwartzkopf said, this was the first space war. There will never be another war without space, and access to it will be essential for future victory. But space is important for more than just military reasons.

Space has become big business, and business yields economic power. It is considered by the United Nations to be one of the five most important technology areas in terms of economic potential.[6] Over $30 billion was spent in FY 1994 for military and civil space operations alone.[7] Revenues for the U.S. commercial space industry were about $5 billion[8]. The international commitment to civil space is also large - about $9.7 billion - and the global market for commercial space industries is estimated at over $7.8 billion.[9] Thousands of companies now take all (or a substantial portion) of their revenues from space activities such as satellites, ground terminals, or launch vehicles. All major telecommunication businesses include some space segments. Entire industries have developed because of the economic benefits of space, and those industries ply their trade internationally. For example, the Direct Broadcast Satellite (DBS) market has boomed - nine companies have already received FCC approval to build satellites for direct-to-home transmission and reception of video and data broadcasts[10]. The U.S. government has begun to flex its economic muscle in this area, first denying access of technology to certain countries, then permitting U.S. space companies to participate in the latest commercial ventures.[b] The government has even exploited the international economic power of space flight directly in support of foreign policy objectives. Since its inception, the International Space Station (formerly the Space Station Freedom) has been a cooperative, semi-commercial venture between the United States, the European Space Agency, and Japan. All involved recognize the benefits of shared

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[b] As an example, the U.S. government recently granted Lockheed Missile and Space Company approval to market satellite imagery of limited (1 meter) resolution. This was in direct reaction to the commercial imagery the French SPOT corporation has started to sell.

capital costs as well as the tremendous potential market for space research and development. As an economic tool of U.S. national strategy, the potential for space is extremely powerful.

Access to space has also become a political tool. Joint space ventures with other nations signal U.S. readiness to share technology with friendly governments and recognize countries as technological equals. Several countries use U.S. boosters to place satellites in orbit, though this trend is decreasing as foreign and U.S. companies find cheaper access on foreign boosters such as the European *Ariane*. In the ultimate political "reward," the U.S. has invited several countries to fly astronauts on the NASA Space Shuttle, most notably German, British, French, Mexican, and Saudi Arabian astronauts. NASA is currently conducting a joint venture between the Space Shuttle and the Russian MIR space station, and has flown a Russian cosmonaut on the Shuttle as part of that project. This use of national space capability has limited economic benefit or military implications - it is a political "carrot" plain and simple. But it is a prestigious one. Manned space flight is a capability currently limited to just two of the world's most powerful and technologically advanced countries. Other countries must share the glory - and gain the experience - at the pleasure of their two powerful friends.

Most developed countries recognize their future is inexorably tied to outer space. For all the political, military, and economic benefits discussed above, every advanced country - or country trying to become advanced - wants a piece of the "space action." China, Japan, and France have their own boosters. India, Mexico, Australia and Israel are building and launching satellites. The economic and military benefits of space access are enormous, and the loss of such access potentially devastating. Space is quickly becoming the great equalizer of international power, and every nation is scrambling to get on board. With international space involvement taking off at breakneck speed, the United States, arguably the current leader in the space arena, must continue to set the pace - or risk falling behind. Our current space policy is one of gradual

expansion of existing capabilities. That may not be enough to maintain leadership in the future. In the past, it was the giant leaps that kept us in the forefront.

THE TREND FOR THE FUTURE

Twenty-seven years ago, the (former) Union of Soviet Socialist Republics (USSR) stunned the world with a 23" aluminum ball called "Sputnik." With its tiny on-board radio broadcasting a "beep beep" to all who could listen, this simple satellite was, quite literally, the space shot heard 'round the world. Sputnik revolutionized the world, and for the next 12 years the United States played a game of evolutionary catchup, making small (albeit remarkable) advances along the journey into outer space. With the first manned lunar landing in 1969, the U.S. revolutionized space travel by "conquering" a new world. That "giant leap for mankind" led nowhere, however, as we abandoned the moon for projects closer to home. In May 1973, the U.S. began the next revolution in space. With the launch of SKYLAB, and the subsequent repair mission 11 days later, humans first *lived* in space. Mankind not only established a presence in space, but made it home. However, it was a temporary home, and the revolution was a short one - at least for the United States[c]. Since then, we have returned to the evolutionary approach of enhancing existing space applications rather than creating new ones. Baring a major policy shift in either civilian or military space channels, the U.S. will continue along this course.

The next 25 years will see further exploitation of space in two prime areas: imaging and telecommunications.[d] Demand will increase exponentially, and supply will increase in response. Many countries will participate, either by purchasing access on other countries' satellites or by

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[c] Russia still maintains a permanent manned presence in space. Space station MIR has been continuously inhabited since 1984. While the U.S. has been developing its space station since 1987, it will not be permanently occupied until at least 1999. Permanent presence in space is still only a Russian revolution.

[d] The need for space-based navigation systems will increase, but will be satisfied by additional ground equipment using the existing GPS satellite network. If properly maintained, the existing network will meet all foreseeable needs for the next 30 years.

building and operating their own. Commercial applications, however, will far out pace military ones, and will become the domain of international businesses or state-sponsored consortiums such as the European Space Agency. The military will find it economical to satisfy much of its telecommunication needs through commercial satellites. If current trends continue, the only uniquely military applications of space will be reconnaissance and attack-warning.

The above requirements can be satisfied by building bigger, better versions of existing satellite systems. Since all existing systems operate via remote presence, i.e., without collocated humans, there will continue to be no need for man in space. This is particularly true for military applications such as reconnaissance and attack warning, which are ideally suited for remote operations. To be sure, man will continue to have a small role in conducting experiments or launching satellites from the Space Shuttle (or its derivative.) However, manned *presence* in space, particularly *military* manned presence, will not be an essential element of our national exploitation of space. Based on the way we use space and operate space systems today, military presence is not required - or desired. But today's way of conducting business should not be a blueprint for tomorrow's. To maintain the U.S. lead in space activities, as called for in our national strategy, it may be appropriate to re-revolutionize the way we do business by involving man more directly, and more permanently. "It is unwise to specify in advance all the limitations we will place on our use of force"[11] according to the national strategy, yet this nation may be doing exactly that by excluding military man from its future space architecture. Human presence offers potential to enhance operations in space; that will become obvious in the next section. To reach that potential, however, man must be used *appropriately* and *efficiently.* Understanding attributes and limitations of humans in space is the first step towards using them to efficiently. Only then can we assess the impact humans can have on national space strategy.

MAN IN SPACE: LIMITATIONS AND CAPABILITIES

Man versus machine: the argument over the utility of space soldiers always boils down to an issue of man versus machine. Critics of the manned space program, military and civil, insist on comparing man's capabilities in space to those of the machines we use in his place. Arguing in those terms, the man always comes out lacking - but it can be no other way. That's why man uses tools in the first place, to accomplish things he cannot do unaided. Man will never see with the naked eye as well as imaging satellites do, and he will never "hear" the electronic signals our communications and intelligence satellites routinely relay. But neither will a man run as fast as a horse, swim like a dolphin, or soar like an eagle. We have automobiles, ships, and airplanes to accomplish what man's physical limitations cannot. On the other hand, robots do not perform surgery, computers do not dispense justice, and electronics do not make decisions to launch nuclear weapons. Those capabilities are either too complex, or too sensitive, to entrust to even the most technologically advanced machines. The best approach is to capitalize on the best of both man and machine, and that requires understanding of what man and machine do best.

A fair comparison of man and machine must be made in three areas: physical (functional), cognitive, and judgmental. In the physical sense, man is limited in visual acuity, sensitivity and resolution, and has no capability to sense electromagnetic radiation outside a very narrow spectral bandwidth. He also lacks endurance, and demands a very complex life support infrastructure to stay alive. He also does not perform repetitive tasks as consistently or efficiently as machines. In terms of flexibility and dexterity, however, man's physical ability far exceeds that of any machine. When equipped with an assortment of general and special purpose tools, there are few tasks he cannot accomplish. Overall then, man and machine are roughly

equivalent when evaluated in a physical context, with machines being more efficient and man being more flexible. Used together, however, synergism and serendipity take effect: man and machine are much more productive when used in combination, often in surprising ways. Such an obvious conclusion appears inconsequential, but it is often forgotten when considering the role of man in space.

In terms of cognitive functions, machines are becoming more sophisticated every day. They now have the ability to measure and characterize a wide assortment of phenomena with far greater precision and accuracy than humans. They can compare what they "see" against patterns stored in electronic memory with astonishing speed. But unless the pattern in memory is almost identical, the machine cannot "recognize" what it "sees." Variations outside a very narrow - and predictable - range will confound the machine. For example, a computer might recognize the image of a tank from it's profile, but fail when presented with an oblique view, or one partially obstructed by smoke. On the other hand, the human brain excels at pattern recognition. Even when confronted with a radically new "image," under unexpected conditions, the human mind can process it almost immediately into familiar shapes and patterns. Imagine running into an old friend at an overseas airport. Despite a new hairstyle and different clothes, and absolutely no expectation of seeing that particular friend at that time or place, he is recognizable. Computers are a long way from that capability. In other words, if the task involves quantifiable changes from an expected situation, the computer is far better suited to the job. Given enough memory, time and effort, the computer can be programmed to deal reliably with almost any *predictable* event by sequentially comparing the current situation with pre-programmed events. When it finds an event that "matches," it takes pre-programmed actions. That's the basis behind today's computer-based "expert systems." Even unlikely events can be programmed, as long as they are predictable. But if there is no match, there can be no action (other than a default "when all else

fails, call for help!") The tradeoff is between the effort required to program the machine and the likelihood of that event occurring. The human mind, however, works differently. In some as yet unknown fashion, it processes information by almost instantaneous association with other events, then finds the similarities. An example serves to illustrate the cognitive difference between man and machine. Given a Rorschach "ink blot" test, the human mind sees some sort of image almost immediately. It does not process it by asking "Is it a dog? No. Then is it a flower? No. Then is it a DNA molecule? No. Then ...." But that's similar to the way computers work. In short, computers process for *differences* while humans process for *similarities*. In terms of the cognitive function, computers excel at the quantifiable, the repetitive, and the predictable; humans have the edge in areas of the unexpected, where originality and creativity are required. Both have their place in the space arena, just as the physical capabilities of man and machine have distinct, but complimentary roles.

Whereas physical and cognitive comparisons between man and machine are somewhat easy to understand and evaluate, a discussion about "judgement" is far more difficult. Much of the difficulty is due to the lack of understanding about the judgement process itself. How, for example, does a doctor decide to stop treating a terminally ill patient? What methods do jury members use to decide guilt or innocence "beyond a reasonable doubt?" How would the President decide if a lone ballistic missile on course for the United States were an accident or a planned preemptive strike? And what retaliatory action is appropriate? Clearly computers could use advanced statistical processing methods to determine correlation coefficients and maximal likelihood estimates. Scientists might rationally argue that computers are *better* suited to those decisions, because machines would not be swayed by intangible considerations such as circumstances, feelings, and consequences. Yet none of us is ready to trust computers with those decisions. On the other hand, we expect good judgement and "common sense" from almost

every human being. The military places a premium on a person's ability to exercise judgement and places inordinate amounts of faith and trust in people to exercise it wisely. Money is saved, lives are spared, and international incidents are avoided every day because properly trained men and women in uniform exercise good judgement. Whether or not computer technology of the next few decades can implement the judgement process, it will be a long time before people are ready to trust that judgement on matters of significance. Judgement, therefore, is almost exclusively the domain of man - on earth or in space.

Capabilities and limitations - man brings both to the space arena, just as he does to the land, air and sea arenas. So do machines. The above discussion was not intended to be an exhaustive comparison, rather to point out what should be obvious: men and machines have unique abilities. Machines bring strength, stamina, precision, and endurance. Humans bring flexibility, adaptability, creativity, and judgement. Are those traits useful in space? A short review of past accomplishments by humans in space will show those traits are not only useful, but essential to the mission. And what, after all, is more important to the military than accomplishing the mission?

MAN IN SPACE - CASE HISTORIES

History is replete with space operations where humans reacted to unexpected situations in unplanned ways to accomplish mission objectives. During the *Faith 7* mission, the last flight in the Mercury program, a failure in the electrical control system resulted in a loss of the automatic re-entry control system. Air Force Captain L. Gordon Cooper took manual control of the vehicle during the critical re-entry flight phase, and piloted the vehicle to a pin-point landing in the Pacific Ocean, just four miles from the waiting recovery ship.[12] Although the astronauts practiced controlling vehicle attitude as part of their normal training, they never anticipated the need to guide the vehicle during reentry. Such precise control was considered impossible by the system engineers. It was the first of many cases where astronauts reacted to unexpected situations, applied training in unforeseen ways, and saved the mission, the lives of the crew, or both.

When the engines of the Titan booster rocket under Gemini 6 shut down only 1.2 seconds after ignition, astronaut Lt Commander Wally Shirra made a split-second decision. If the engines had fired long enough to lift the booster even a few inches off the pad, the rocket would come crashing back to the ground, destroying the booster, killing both astronauts, and damaging the launch pad. A similar case of premature engine shutdown occurred in the early days of the space program, when the unmanned MR-1 Mercury-Redstone rocket lifted a few inches off the pad before engine cut-off. If he pulled the "chicken ring" and ejected, both he and fellow astronaut Tom Stafford might be severely injured and the mission scrubbed, eliminating the chance to conduct the all-important first rendezvous with the Gemini 7 spacecraft already in orbit. Although mission rules clearly dictated he should eject, Shirra's instinct was that the rocket had

not moved. He chose not to eject - and the rocket was fixed and launched successfully three days later, rendezvousing with Gemini 7 and completing all mission objectives.[13]

The first Apollo lunar mission provides the most dramatic example where the man in the loop prevented certain disaster, yet it received little attention by the public precisely because no disaster occurred. Despite years of mission planning to select a safe landing spot, flight controllers unknowingly programmed the lunar module *Eagle* to land in a field of boulders. In the final minute of the descent to the moon's surface, astronaut Neil Armstrong recognized the danger, took manual control, and searched for an alternate landing site. With less than 30 seconds of fuel remaining before a mandatory mission abort, Armstrong located a flat area and guided the fragile craft to a safe touchdown. If not for his unplanned actions, the mission would certainly have failed and the country would have suffered a serious blow to national prestige.

The flexibility and adaptability of astronauts were put to the ultimate test in May of 1973, with the launch of America's first (and so far only) space station - *Skylab.* During launch on 14 May, the space laboratory's meteoroid shield ripped off, and took with it one of the two main solar arrays that provide electrical power. This shield not only protected the vehicle from meteor damage, it provided thermal control by reflecting solar heat. As pieces broke off, they damaged or jammed other critical components, including the deployment mechanism for the remaining solar array. The result was a crippled spacecraft, too hot to inhabit and too underpowered to operate. The entire $2.5 billion project appeared to be a "total failure." [14] Yet 11 days later the crew, commanded by Navy CAPT Pete Conrad, rescued the vehicle with the most extensive - and ingenious - repair actions ever conducted in space. In the first day alone, the crew performed an Extra Vehicular Activity (an EVA, or "spacewalk") to deploy a makeshift "parasol" to replace the solar shield, partially disassembled the docking mechanism in order to connect the command module to the *Skylab*, and struggled, unsuccessfully, to deploy the stuck solar array. As the

makeshift solar shield brought temperatures to barely habitable levels, the crew conducted what few experiments were possible with the limited electrical power. Finally, almost two weeks after arriving, the crew made another attempt to release the stuck solar array, using procedures developed by astronauts on the ground and radioed to the crew on orbit. During a 3.5-hour EVA, Conrad, together with astronaut Joseph Kerwin, cut away an aluminum strap that was holding the array and forced the array open. Within hours the batteries were charged and *Skylab* was restored to almost full operational capability. Despite the damage, and the time spent repairing it, the first *Skylab* crew was able to perform virtually all medical experiments, three-quarters of all planned solar observations, and about 60 percent of the scheduled remote-sensing experiments.[15]

Repairs in space are by no means limited to U.S. astronauts - Soviet cosmonauts have demonstrated impressive repair capabilities as well. The Salyut 7 space station, first launched on April 19, 1982 and remaining operational until November 1985, suffered numerous small failures and two mission-critical ones. Sixteen months after launch, a fuel line aboard Salyut began leaking, rendering its propulsion system inoperable. Cosmonauts Leonid Kizim and Vladimir Solovyov conducted six EVAs lasting a total of 22 hours to repair the defective propulsion system. On October 1, after 236 days on orbit, the crew returned to earth, leaving the station unoccupied. Unfortunately, ground controllers lost all contact with the Salyut four months later. So confident were the Soviets in the abilities of their cosmonauts, however, they launched a repair crew despite having no idea what failure had occurred. There faith was rewarded. On June 8, 1985 cosmonauts Vladimir Dzhanibekov and Viktor Savinykh rendezvoused with the tumbling spacecraft. After troubleshooting the powerless craft, they discovered a failure in one of the battery charge circuits which had drained all eight batteries and prevented them from being recharged. Bypassing the failed circuit, they connected the six still-functioning batteries directly to the solar panels. Within hours the batteries began charging, and the spacecraft came to life.

During the next ten days the crew checked every on board system. Subsequent supply missions brought repair parts, and the crew made the station fully operational.

Human accomplishments in space are not limited to repairing unexpected failures. Some of the most significant examples involve systems *designed* to take advantage of man's flexibility. With the advent of the U.S. Space Shuttle, several U.S. satellites incorporated design features permitting easy capture and repair by Shuttle astronauts. The Solar Maximum Mission satellite ("Solar Max") was built with replaceable electronics modules and a grappling adapter for the Shuttle's "robot arm" to grab. Shuttle Mission 41-C, launched on 6 April 1984, rendezvoused with the ailing satellite to replace two malfunctioning units and restore satellite capability. Though the mission almost failed because of badly designed grappling hardware, mission commander CAPT Robert Crippen led his crew in a last-ditch effort to capture the satellite, despite ground controller fears that capture was impossible.[16] The next day, astronauts George Nelson and James Van Hoften conducted an EVA to replace the broken units. Solar Max was redeployed and continued it's mission. The success of mission 41-C led to other, more complex repair missions, including the now famous Hubble Space Telescope repair.

Shortly after the Hubble Space Telescope (HST) was deployed from the Shuttle Discovery in April, 1990, engineers discovered a major flaw in the telescope's optical system. Although HST was designed specifically for repair and refurbishment by Shuttle astronauts, no one anticipated on-orbit repairs of this magnitude. [e] Three years later however, astronauts installed a specially designed optical package which corrected the flaw. In addition, they replaced several other components to restore full function or enhance the telescope's capabilities. The complex repairs were possible only because of the design features of HST and the abilities of the crew.

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[e] In 1986, the author spent many hours in a simulated weightless environment, evaluating repair techniques for the HST.

The Hubble telescope represents the first generation of space hardware designed specifically for on-orbit repair and maintenance. Although the Solar Maximum satellite had man-friendly features to support *contingency* operations, its designers never expected the need for on-orbit maintenance. The HST mission, however, anticipated and planned for Shuttle visits to install equipment upgrades. The space stations of the former Soviet Union belong to this same generation. Both Salyut and MIR were designed for on-orbit growth: cosmonauts connected additional solar arrays to increase the power available for mission experiments, and even added additional living modules to expand the core space station. But astronauts and cosmonauts have also conducted numerous experiments related to next-generation space servicing. Astronauts have assembled large structures, developing the techniques for building the International Space Station. They have transferred fluids between pressurized tanks, "practicing" for spacecraft refueling. Cosmonauts have soldered electrical components and welded metal pieces, seemingly trivial tasks that become difficult - and dangerous - in the microgravity environment.[f] In short, humans in space have demonstrated, albeit on a small scale, the full range of operations, repair, and maintenance tasks performed by military personnel on earth. They have served as troubleshooters, engineers, scientists, technicians, and test pilots. Astronauts have brought all the flexibility, versatility, adaptability, cognitive skills and judgement in which humans excel into space with them. They have proven they can do whatever job is required. Now the question becomes: Is there a job for military humans in space? Previous military leaders thought so - over the last 35 years there have been 5 military programs dedicated to using - or exploring the use of - military man in space.

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[f] Without gravity, molten metal does not necessarily "flow" where it's needed, nor does it stay in place while cooling. In many cases, small "blobs" of molten metal break away, forming spheres of metal that drift throughout the spacecraft. These tiny balls of conductive material can wreak havoc on the electrical equipment. Several equipment malfunctions on the shuttle were attributed to almost microscopic "solder balls" inside sealed components.

MILITARY ASTRONAUT PROGRAMS

The U. S. Air Force has repeatedly initiated programs to use humans in military space missions. Even before the first man in space, USAF had plans for a manned space capability. In April 1957, over a month before the Sputnik launch, the Air Force began the *Dyna-Soar* (Dynamic Soaring) program, a research effort to build a reusable space plane to ferry astronauts to earth orbit and back.[17] At the same time, the Air Force was working with the newly created National Aeronautics and Space Administration on the Mercury and Gemini space capsules, intending to have its own "Blue Gemini" program to conduct military surveillance missions. For more complex operational missions and experiments, USAF planned the ambitious Military Orbital Development System (MODS), basically a small space station. But in 1963, Secretary of Defense Robert McNamara cancelled all three programs, stating "We don't have any clear military requirement, or any known military requirement." [18] The start-stop pattern of military space activities was a pattern to be repeated many times in the future.

The same day Secretary McNamara cancelled *Dyna-Soar*, the Air Force started an even bigger program than MODS, the Manned Orbiting Laboratory (MOL) program. The MOL was a small space station, from which military specialists would conduct various military operational missions and experiments. Crews would stay in orbit 30 days, and be shuttled back and forth via an Air Force-operated Gemini capsule. The Air Force selected and trained its own group of astronauts for MOL, built a specialized launch pad at Vandenberg AFB, and even launched a mock-up of the laboratory.[19] Six years later however, amid Soviet concerns over the program,[g]

[g] Ironically the Soviets, fearing the potential military applications of crews in space, pressured the U.S. to cancel the MOL program. At the same time, however they were developing their permanently manned Salyut space station.

Vietnam-induced budget limitations, and continued arguments that satellites could out-perform man in space, the program was cancelled.[20] It would be ten years before the military tried again to establish it's own manned space program.

Following the successful Apollo lunar program, the United States as a whole was uncertain of the future of manned spaceflight. The increasingly sophisticated unmanned space probes (Pioneer, Voyager, Viking) returned vast amounts of scientific data and, more importantly, visually stunning images that captured what little enthusiasm the public had left for space exploration in the 1970's. At the same time, NASA could no longer generate public support or funding for its long-range manned program, which originally included a permanently manned space station, a lunar outpost, and a reusable transportation system to support them. Faced with increasing budget restrictions, NASA reduced its ambitious program piece by piece, until only the reusable launch system remained. Even that was drastically modified from its original, fully reusable design to the partly reusable Space Shuttle system in use today. Meanwhile, the military had no manned access to space and, understandably, would not develop such a capability if it could take advantage of the NASA program instead. In the late 1970's, as the NASA Space Shuttle program solidified, the military's "piggy-back" opportunity came - and they took it.

In 1979, Secretary of the Air Force Hans Mark created the Manned Spaceflight Engineer (MSE) program to "develop expertise in manned space flight and apply it to Defense Department space missions."[21] From 1979 through 1986, 32 officers (Navy and Air Force) were eventually selected and trained as military astronauts for this program.[22] MSEs trained in all aspects of manned space flight, becoming familiar with all shuttle systems and operations, but concentrating on the operational details of specific payloads to which they were assigned. MSEs even trained

for extravehicular repair and refurbishment of satellites.[h] The goal was to fly the MSEs as dedicated payload specialists[i] on the Shuttle during missions involving DoD payloads. Their expertise would aid the Air Force in building new spacecraft and "integrating" space into military operations. At the height of the program, Air Force policy was to fly an MSE on every DoD Shuttle mission.[23] Ultimately, two MSEs flew on the Shuttle (missions 51-C and 51-J), and as many as twelve more were assigned to specific flights. Yet the MSE program was only a small part of the Air Force's commitment to a manned space program.

By executive direction, the military was to use the Space Shuttle as the primary launch vehicle for all DoD payloads. Not wanting to entrust national security missions to a civilian organization (NASA,) the Air Force began its own "Blue Shuttle" program. Even before the first Shuttle launch in 1981, the Air Force started work on the Shuttle Operations and Planning Complex (SOPC,) a launch and operations control center to be built in Colorado Springs and run by what would become the Air Force Space Command. It was to be an ultra-secure military version of NASA's Mission Control Center at the Lyndon B. Johnson Space Center in Houston, Texas. Air Force officers were detailed to NASA to train for and support all aspects of shuttle operations, from mission planning and payload integration to on-orbit control of communication hardware and life support systems. In 1983 the newly created Air Force Space Command established the "1st Manned Spaceflight Control Squadron" at the Johnson Space Center (JSC.)

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[h] One MSE, Navy Commander Dave Vidrine, was scheduled to fly aboard the STS 41-C "Solar Max" repair mission. He trained side by side with NASA astronauts Nelson and Van Often in capturing and repairing the satellite, paving the way for similar missions involving DoD satellites. However, one month before the flight he was pulled from the mission by the head of the MSE program, MGen Ralph Jacobson, who claimed Vidrine's involvement "had no value to the Air Force."

[i] The term "payload specialist" was coined by NASA to describe non-NASA personnel with payload-unique experience who flew aboard the shuttle. While NASA "pilot astronauts" and "mission specialists" were considered career astronauts, the payload specialists were intended to be one-time passengers who flew a specific mission in support of a specific payload or experiment.

The 1st MSCS was little more than a renamed Air Force Systems Command (AFSC) detachment (Det 1, HQ Space Division,) a unit established earlier at JSC to support shuttle operations and coordinate DoD missions. But it represented a major shift in USAF's view of manned missions. They were no longer in the realm of the research and development command (AFSC). Manned space missions were considered so "routine" they could be run in typical USAF "operational" fashion, like a tactical fighter wing mission. AFSPACECOM built a solid infrastructure around SOPC and the 1st MSCS, including formalized training programs, a wing-level command structure for the SOPC, and specialized career paths for the assigned military members. The goal was to move to a fully operational SOPC in the mid 1980's, planning and eventually operating dedicated national security DoD missions with personnel from a relocated 1st MSCS. DoD specialists (MSEs) would fly on all DoD shuttle missions, controlled by Air Force members (1st MSCS) at an Air Force control center (SOPC.) A military manned space mission in support of national security seemed secure. But manned space flight was still controversial, and there was - ironically - dissention within the Air Force itself as to its utility. During the initial successes of the shuttle mission in the early 1980's, there was too much enthusiasm for the critics to dampen the momentum. Then, on 28 January 1986, the Space Shuttle *Challenger* exploded.

THE DEMISE OF MILITARY MAN-IN-SPACE

The *Challenger* tragedy occurred shortly before the third (and final) cadre of MSE's were selected, but, partly out of momentum, the Air Force continued with the program. Yet by the time five officers reported to HQ Space Division in Los Angeles in April 1986 to begin the nine-month training program, it was clear the Air Force had again publicly lost enthusiasm for manned spaceflight. The change of commitment was not due exclusively to the loss of the *Challenger* - but the loss presented an opportunity for numerous critics within the Air Force to argue against continued use of the Shuttle for DoD purposes. The Air Force had fought the decision to use the Shuttle as it's primary launch vehicle. Even though much of the design compromises made to the Shuttle were to meet DoD requirements, many in the Air Force resented the fact the Shuttle was forced upon them. Some felt it unwise to rely on a single booster for all DoD national security payloads, fearing that grounding of the system would jeopardize national security. Some officials still maintained there was no role for military man in space, arguing unmanned systems could replace manned ones at lower cost.[24] Whatever the combination of reasons, the Air Force jumped at the opportunity to abandon the Shuttle as soon as possible after the *Challenger* accident. Many argued the Shuttle was too dangerous and too unreliable for a national security system. One wonders what would have happened had the military abandoned aircraft when the first pilot died in an air crash. In any event, DoD immediately changed it's launch policy, making expendable launch vehicles "the primary vehicles for national security payloads not requiring a manned presence in space."[25] Despite trained MSEs ready to fly on DoD Shuttle missions, the Air Force removed the military members from the flight crews. In August 1988 the Air Force officially cancelled the MSE program.[26]

The last investigation into the role of the military in space was a study effort begun in 1987 and conducted for three years by AFSPACECOM, the "Military Man-In-Space" (MMIS) program. Rather than fly dedicated military astronauts like its predecessor, the MMIS program was designed only for ". . . exploring military man's capabilities in space."[27] It did this by flying simple experiments on the Space Shuttle which were conducted by NASA astronauts whenever possible, or perhaps by a military specialist. Those experiments, however, tended to be reconnaissance oriented, such as "What targets can be seen on the ground?" And while there have been some impressive observations, those activities still fall into the area where dedicated unmanned platforms can perform far better, and far more reliably. As a result, the MMIS experiments did not engender much faith in man's added value in space. Senior officers from both AFSPACECOM, which ran the program, and USSPACECOM, it's parent unit, expressed doubts about the value of manned spaceflight in general, and the MMIS program in particular.[28] General Donald Kutyna, former head of USSPACECOM and the sponsor of the MMIS experiments, said that tests involving visually tracking ships' wakes and coordinating communication networks from a simulated on-orbit "Command and Control" platform have little value. He stated the MMIS experiments were ". . . just awful. What they amounted to is looking out the window and saying 'Gee, isn't it pretty out there?'"[29] While his comments may be unnecessarily harsh, they make the correct point. Military man's contribution to national security will not be personally observing ship movements from space in time of peace. It will come from the on-scene judgement and flexibility he can bring to the battle zone. With a little imagination, one can envision a host of possible applications for the military in space, possibilities already demonstrated by American astronauts - and Russian cosmonauts.

POTENTIAL JOBS FOR MILITARY MAN-IN-SPACE

We have barely scratched the surface of man's capabilities in space. One need only compare operations in space to existing land, sea and air operations to realize how much potential remains. Official Air Force policy, states that USAF "must prepare for the evolution of space power from combat support to the *full spectrum of military space capabilities*"[30] (emphasis added.) The full spectrum ranges from pilot to experimenter; bombardier to repairman; combat engineer to saboteur; command and control to intelligence. Almost any job performed by military members on the ground may one day be needed in space. Remote dockings of space craft have been performed since the Gemini program, but skilled pilots will be needed when the preplanned options fail, as in the Solar Max mission, or the risks of failure are too great, as in the February 1995 fly-by of the Space Shuttle Discovery with the Russian MIR Space Station. Consider an intelligence mission, where USAF pilots maneuver to a foreign spacecraft to learn more about it's operations, or even "capture it," a capability the former USSR accused the U.S. Space Shuttle of having. Navy SEAL (Sea, Air Land) operatives train for (and possibly perform) that type of mission with military systems today. Army special forces troops performed a variety of covert operations against the command and control system of the Iraqi army in preparation for the start of the Gulf land war. With more and more Command, Control, Communications, and Intelligence (C^3I) being based on satellite systems, is it unreasonable to project a need to one day "sabotage" satellites? And with the cost of those systems ranging from $50-500 million dollars (not to mention the $60-400 million dollar launch cost) financial prudence dictates we keep them operating as long as possible by building in a repair and refueling capability. Both functions have already been demonstrated - and yet numerous satellites end their useful life because they

exhaust the fuel supply. In almost all cases, controllers restrict spacecraft operations in order to conserve fuel. Imagine prohibiting manned bombers to operate at low altitudes because it uses too much fuel. The DoD solved that problem by building mid-air refueling capability into almost all it's aircraft - why not consider it for satellites? Skeptics argue that refueling could be automated, or controlled remotely. This is certainly true - but having humans on the scene has always provided unforeseen benefits, and provides the additional capability to perform on-orbit repair. General Kutyna made a valid point in his critique of man in space when he dismissed man's role in satellite repair by saying it's too expensive to "take Mr Goodwrench out to those orbits" where most military satellites fly.[31] The majority of current military satellites do operate at altitudes or inclinations outside the range of the current Space Shuttle, but that problem can be solved. It would be a simple (though initially costly) project to build an Orbital Transfer Vehicle, a ferry capable of shuttling astronauts to and from payloads in other orbits (or vice versa) - even out to geosynchronous orbit where the majority of military and civil communications satellites operate. NASA included such a vehicle in it's early plans for post-Apollo activities.[j] With similar planning and additional investment, the ability to perform the *full spectrum of military space capabilities* called for in Air Force policy can be achieved.

Current aerospace policy lists four mission areas for space forces: Force Enhancement, Space Support, Force Application, and Space Control. Present day systems center on the first two areas, providing data that enhances the operations of ground forces (navigation, weather communication, intelligence) or providing logistical support to the satellites (launch, on-orbit control, etc.) While both these mission areas could be augmented by having humans on the

[j] Ironically, the Russians built such a "tug" for use with the MIR space station. The U.S. recently agreed to buy it for $190 million as the first element of the International Space Station. (Reported in "U.S. Will Buy Russia Space Tug", Space Defense News, Feb 1995)

scene, Space Support has the greater potential - "Mr Goodwrench" is a space support officer. Current Air Force doctrine has already forseen the need:

> Ultimately, a space platform's effectiveness can be significantly expanded by providing vehicles and crews to repair or modify the platform, to service it, or to restock such consumables as fuel. The maintenance base, recovery systems, and in-space repair capabilities are therefore essential to the persistence, presence, and reliability of space forces. [32]

Force Enhancement would benefit if we were to transfer the command and control function to space. A space-based control center could operate much as the Cheyenne Mountain complex now operates for the North American Aerospace Defense Command and US Space Command. Located in mid-earth orbit, it would be capable of global command, control, communications, and intelligence functions - without need for the ground stations current systems rely upon. At that altitude, it is also relatively safe from anti-satellite weapons.[k] When we start operating small fleets of transfer vehicles and perform repairs (and possibly covert activities) on satellites, a centralized, on-scene control function will be even more advantageous. While these scenarios can - and should - all be performed in the next few decades, there are other areas to exploit in the near term.

The other two space mission areas offer far more interesting applications for man in space. Force Application is the use of military force from space to targets on the ground or transitting space (such as missiles.) The best example is the use of orbiting lasers to destroy incoming ballistic missiles, but it might also include an offensive capability to apply directed energy, or even kinetic energy weapons, to targets on the ground. Space Control is analogous to

[k] Current direct-ascent ASAT systems can threaten low orbiting satellites because the short time between launch and impact makes defensive countermeasures difficult. Satellites in higher orbits will have more warning of impending attack, and can take appropriate counter measures. In addition, directed energy weapons are far less effective at the distances involved in the higher orbits.

the Air Force concept of controlling the air, i.e. ensuring the ability to use friendly space assets while denying the adversary's use of his space assets. It deals with defensive systems to protect U.S. operations in space, and offensive systems to attack enemy space assets. While it's true that some of the offensive space control mission can now be performed by the ground (destroy the ground control station and the satellites are out of action) that will not be the case in the future, as satellites, our's and our potential adversary's, become more autonomous. There may also be times when a more covert, less provocative means would be in order - and that may require man in space. And if we do return to the idea of weapons in space[1] it would be wise to put them under the on-scene control of well trained military personnel. Past and present procedures set the precedent. Despite having capability to launch weapons without man in the loop, the military nevertheless insists on putting humans on the firing control circuits at or near the weapons. Whether it's done for added security or just for the public's peace of mind, we would want no less for weapons in space. And there is another, subtler point to manning the space-based control centers and weapons: the presence of humans provides a deterrent. A satellite in orbit, no matter how expensive, is just a piece of machinery. Nations don't go to war over machines. But put one seemingly insignificant soldier, sailor, or airman on that machine, and suddenly national sovereignty is threatened. In times of future crisis, hostile space assets will become targets. It's one thing to destroy an unmanned satellite: at the risk of sounding melodramatic, satellites don't have mothers. But if a nation kills a soldier while attacking that satellite, it risks strong national response. That kind of deterrence may keep satellites safe - and nations at peace. And that, after all, is the goal of the military, no matter what operations it's performing, or where.

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[1] While many people believe current treaties prohibit the use of weapons in space, only *weapons of mass destruction* (nuclear, chemical, and biological weapons) are currently prohibited. And there is nothing to prevent us - or others - from abrogating such a treaty if required.

The above examples are just of few of many military space tasks which may one day become common place. The point is that *all* military operations can be conducted in space - just like military operations conducted in land, sea, or air. And *where appropriate* man should be conducting the operations. Yet the policy is fundamentally different for operations involving space. Why? Should it be?

MILITARY DOCTRINE - DIFFERENT FOR SPACE

Space policy today is a victim of the very issue that makes it important in the first place: technology. During the early days of the space program, most of the attention (and civilian funding) was focused on the manned aspects - i.e. getting a man to the moon. Technology made that possible. But at the same time, technology was advancing rapidly in fields of remote control, tele-presence, and robotics. Just as technology was enabling man to accomplish valuable missions in space, it was also obviating man's presence via remote sensors, communication links, and robotics for many of the same missions. For the first time in military history, the available technology has been sufficient to perform the mission as each mission became necessary. By way of comparison, consider the mission of a naval surface ship. It is either to ferry materials, protect (or attack) lines of communications, or protect (or attack) other ships performing those missions. That basic mission has been around for millennia - the Peloponnesian war is filled with naval battles performing those missions. With the technology available in those times, there was no way to perform that mission without man on the scene, in this case on the ship, controlling the sails, firing the cannons, manning the oars. It was impossible to conduct the mission via remote control, and so man was (and continues to be) an essential part of the military doctrine of the navy.

Air Force history is the same, and more illustrative. The earliest mission of airpower was reconnaissance. Observers would ride aloft in hot air balloons, viewing the enemy formations and reporting back to commanders. With the available technology, it was impossible to control the balloon or view the battlefield remotely. As technology evolved to more complex, heavier-than-air craft, it became even more difficult to pilot the vehicles remotely, or conduct the other

missions increasingly assigned to aircraft. As in the case of the Navy, doctrine and tradition developed firmly around the concept of man on the scene - so much so that any proposals to limit man's involvement have been, until very recently, readily discarded as infeasible or undesirable. Today's technology finally makes it possible to perform many missions without having man directly on the scene, yet doctrine and tradition make the progress slow. Despite rapid advances in artificial intelligence, remote sensing, telepresence, virtual reality, and robotics, many senior military strategists insist airplanes must have pilots, submarines must have sailors, and tanks must have drivers. There has been some research into more automated systems, but momentum and tradition make for significant resistance: "We've always done it that way - why change now?" Self-preservation plays a roles as well: "What becomes of the Air Force if we eliminate the pilots?" Such arguments will exist in any bureaucracy, for the "prime directive" of any bureaucracy is to maintain the status quo. But there are legitimate arguments as well. Human presence provides numerous unique, if not always quantifiable benefits. It also provides additional cost - in complexity and risk to human life. Still, the flexibility, judgement, and reliability of man on the scene are important and vital parts of our military doctrine and strategy.

The history of space as a military mission is different, and so is the national policy regarding it. The technology which enabled the space age also enabled certain missions to be conducted without man on the scene, most notably remote sensing, surveillance and reconnaissance. While NASA was capturing the public attention with spectacular manned missions, a large community of scientists and engineers was secretly using space technology to take man **out** of reconnaissance missions.[m] As technology matured, other military missions took shape - communications and data relay, for example. Commercial industries followed the lead,

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[m] Many details of the National Reconnaissance Office are still classified, but its mission to conduct reconnaissance over denied territories, and the fact it uses satellites to do so, has been publicly acknowledged.

as they have done throughout history, and a thriving telecommunications and remote sensing industry developed around unmanned space technology. Now an entire bureaucratic infrastructure and a successful industry have been built around space missions which do **not** require the presence of man, and bureaucracies, as noted above, resist change. As such, it is difficult to convince those agencies to investigate missions which not only involve, but *require* man on the scene. In a commercial sector driven by quarterly profit projections and a government hamstrung by enormous deficit, it takes vision and daring to invest in manned missions without immediate payoff. But should we make the investment? Historic parallel suggests we must.

THE DAWN OF AIR POWER

Space as a military theater of operations today is at roughly the same stage of development as air power was 150 years ago, when hot air balloons represented the only capability man had to conduct operations in the air. As early as 1670 the Italian Jesuit Francesco de Lana Terzi proposed using airships for warfare purposes.[33] The first recorded use of balloons in war was during the French Revolution, when French observers in one directed fire against Austrian forces. It was not long before men in tethered balloons were relaying communications between commanders. Until technology provided a capability to control the balloon's movement, the application of airpower was limited to a *force enhancement* role. (The *air support* role began as soon as the first balloon was inflated.) The potential use of zeppelins by the Germans prior to World War I led authorities to seriously consider the use of airships for military purposes, and spurred the development of heavy-than-air planes[n]. Propeller driven airplanes dramatically altered the *capability* of airpower by providing increased maneuverability, flexibility, and range, yet the

[n] The Germans actually bombed Paris and London using the zeppelins; however the zeppelins were extremely vulnerable so the raids stopped.

mission of airpower did not immediately change. First used by the Italians in the Italo-Turkish War of 1911-1912, airplanes still only flew surveillance flights to observe the movement of Turkish Forces. But military tacticians realized the danger of those flights, and developed technology (aerial guns) and tactics to negate them (*aerospace control.*) Although some pilots dropped small bombs from airplanes during World War I (*force application*) it was mostly ineffectual. Not until air power enthusiasts such as Trenchard, Douhet and Mitchell convinced a doubting military community of the potential application of this new form of aerial warfare did the military develop the airplanes and tactics to carry out large scale bombing campaigns. Today we use airpower across the full spectrum of military combat, in ways once thought impossible or impractical by the military establishment. Air power progressed from balloons performing surveillance missions to modern aircraft conducting the entire range of tactical and strategic operations we see today, simply, and inevitably, because it could. Space power has progressed for the same reason - because it was possible. Jjust as inevitably, the progress will continue.

Technology is progressing too - can it continue to keep man from space? No - not if man begins to perform the military tasks he does on land, sea and air. Again the history of airpower provides the precedent. For over 30 years technology has been available to perform many missions of the U.S. Air Force. The ballistic missile, the first application of space power, was built to put bombs on target without needing a pilot - yet manned bombers have always been an essential element of the "strategic triad." Long range cruise missiles obviate the need for manned penetrating bombers, yet the B-2 is high on the Air Force priority list. Today's technology could easily provide a remotely operated transport vehicle[o] - but the C-17 requires highly trained,

[o] Even the Space Shuttle flies most of its mission under computer control. There is even a fully automatic landing system, though it has never been used. The former Soviet Union, however, flew their space shuttle - Buran - completely by remote control, to include the landing. It's difficult to believe technology couldn't provide a similar ability for a cargo airplane - if it were desired.

highly vulnerable pilots, and the life support system to keep them alive. Some have even proposed the idea of remotely controlled, unmanned air-to-air fighters[p]. After all, the pilot has become the limiting factor on aircraft performance. Remote-control technology could impact all services more than it does. Robot ships could transport supplies, fight surface battles, even carry ballistic missiles. Tanks could certainly be run remotely, operated by soldiers safe behind the front lines. Despite all technology could do to eliminate (or at least reduce the need of) humans on the battlefield, we continue putting soldiers, sailors, and airmen in harm's way. We don't do it solely based on tradition, or just to preserve our institutions. Humans are needed because of the capability they bring which technology can not provide - the experience, cognitive skills, and judgment which are so essential in times of crisis. We must recognize that as a basic truth - on land, at sea, in the air . . . and in space. As we consider the future of space for our nation, we must keep that foremost in mind.

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[p] The HIMAT (Highly Maneuverable Aircraft Testbed) was built as a sub-scale test bed for evaluating a remotely controlled attack aircraft.

SPACE IN OUR FUTURE

Space has been described as a place, a mission, a region, the ultimate high ground, and the battlefield of the future. As indicated in the first section of this report, it is already an indispensable part of the present: it cannot help but be part of the future. Civilian and military leaders have proclaimed space a vital part of our military and economic strategy, and our military and economic actions must continue to support that declaration. The United States and a handful of other nations have already established a permanent presence in space. Others will follow suit as soon as their technology and budgets can support them. We have further staked a claim to space as a vital region in the time honored way: we've sent humans to explore it. The Russians have made their presence permanent, and the United States, along with our European, Japanese, and Russian partners, is again on the verge of a permanent manned presence via the International Space Station. The 1995 National Security Strategy (NSS) proclaims "the U.S. has steadfastly recognized space as an international region" and that "retaining the current international character of space will remain critical to achieving U.S. national security goals." The strategy goes on to state that our main objectives in this area include "Continued freedom of access to and use of space;" and "Deterring threats to U.S. interests in space and defeating aggression if deterrence fails."[34] And with a permanent space station in orbit, there will be American citizens in this new "international region," citizens this country must protect when necessary. These are military missions, just as maintaining freedom of the high seas is a military mission.[q]

[q] The NSS itself makes the comparison between access to space and freedom of the high seas.

Our economic infrastructure is also tied heavily to space, and getting more so. Businesses routinely rely on satellites for telecommunication, and supply is increasing to match demand. At least seven commercial satellite projects are currently under development to provide various international networks for improved telecommunications; Motorola's $4-billion Iridium and TRW's $1.5-billion Odyssey program to name but two.[35] The space-based laboratories on the MIR and the International Space Station promise potential for as-yet unknown economic benefits from space-based manufacturing and materials processing. Already companies such as McDonnell Douglas have experimented with ways to manufacture new pharmaceuticals in space (using astronauts to conduct the experiments.) As more business moves there, access to space will get cheaper - and businesses will look for even more opportunities in space. With increased opportunities and reduced access costs, man will naturally play a larger and larger role - as researcher, repairman, process controller, and explorer.

For the reasons discussed in previous sections, man will always provide tangible and intangible benefits. In the past, the military - and military man - has always advanced the state-of-the-art and "pushed the envelope," without regard to cost. Today, for a variety of reasons *including* high cost, the tendency is for the military to follow on the heels of commercial industries - adapting commercial technology and processes whenever possible and advancing technology only where civilian industries have no market. Some argue that should happen in the space field as well. Commercial markets should continue developing the utility of man in space for economic reasons and the military, recognizing the efficiencies, will then adapt its operations to involve space-based military men and women. Others argue the military should continue it's historic role as explorer and developer, establishing the "frontier outposts" into which the commercial markets will move. But in either case, military man will eventually have a presence in space.

Space has become an operating region of interest for mankind, an region of Earth just as the air and sea are regions of Earth. And the military has the duty - and the doctrine - to protect and defend that region. Furthermore, the history of air, land and sea power has shown that where the military has a mission, and the means, the military places men. It is unreasonable and shortsighted to believe space can be treated differently. Military man has a mission in space, a utility in space, and, one might argue, an inevitable destiny in space. In the interests of long-term national security and prosperity, this nation must recognize that fact and commit to an effective and economic plan to make space just another operating location for its armed forces. Surprisingly, such a plan requires little more than coordination and minor adaptation of existing plans. At the same time, it addresses the two reasons critics most often cite as arguments against military man in space: cost and risk.

STRATEGY FOR THE FUTURE:

BUILDING THE INFRASTRUCTURE

The United States must continue to expand its use of space. Faced with global competition, it will either develop new processes for accessing and using space, or it will fall further behind a growing group of nations already exploiting space more efficiently. Already several countries launch satellites at a fraction of the cost of U.S. launches. DoD's 1993 Space Launch Systems Bottom-up Review estimated that the French/European consortium Arianespace launches small to medium payloads into orbit at approximately $8000/pound, roughly half the cost of a U.S. launch.[36] Consequently Arianespace controls 62% of the global market for commercial communication satellites launched to geosynchronous orbit. By comparison, the two main U.S. competitors, McDonnell Douglas and Lockheed/Martin Marietta, control only 36%.[37] China and Russia also provide commercial launch services, and Japan may soon follow.[38] Furthermore, as the U.S. loses market share in launch services, it is also losing its share of commercial satellite construction. In 1994, U.S. manufacturers were prime contractors for building 69 of 99 satellites on order worldwide[39]. While that represents a hefty 70% of the market, it's a drop of 30% from 10 years ago when the U.S. built virtually all commercial satellites. In both launch capability and satellite development, the U.S. is losing its lead. This has not gone unnoticed by government and military leadership.

The United States has focused more attention on the need to enhance our space capability. As indicated earlier, the U.S. National Security Strategy calls for "Maintaining the U.S. position as the major economic, political, military, and technological power in space".[40] Vice President

Gore's Space Policy Advisory Board recognized that the U.S. "space industrial base is being threatened"[41] and calls for numerous changes to the way the U.S. conducts business in the space arena. The most significant recommendation is as follows:

> We should invest in upgrades to the current vehicles and supporting infrastructure to increase reliability and reduce operating costs. . . . Finally, we must develop and make operational a modern, low-cost launch system.[42]

The military leadership agrees, and places the same emphasis on low-cost access to space. General Charles Horner, former Commander-in-Chief of United States Space Command, stated in testimony before the Senate that "U.S. space launch industry must evolve from the mid-'70s technology of our current ELVs [Expendable Launch Vehicles] to brave the space launch challenges of the 21st century" and that we must "make U.S. launch systems more affordable, efficient, flexible, and responsive." Furthermore,

> "unless we change the way we design and launch satellites, we will face escalating launch costs which will inhibit military access to space and could handicap our commercial vendors from becoming internationally competitive."[43]

Meanwhile, industry has already begun the move toward competitive operations. Orbital Sciences Corporation developed the *Pegasus* booster and its more powerful derivative *Taurus* booster. Both are now in commercial operation. Other companies are building and operating small scale boosters designed for sub-orbital trajectories, geared towards a small but growing industry supporting experimental test satellites. Although these smaller vehicles do satisfy some military requirements, the primary need for the military is a new medium-lift space launch capability, since 82% of the DoD space lift requirements fall into this category.[44] And there is still a requirement for heavy-lift capability to orbit DoD's largest payloads, and NASA's space station components. Fortunately, the government has begun several programs to meet these

requirements, and it is in this area that consideration must be given to supporting increased manned operations in space - both military and civilian. Unfortunately, as in the case of military man in space, a lack of commitment to these programs has already delayed operations of more economical systems at least a decade.

The National Aerospace Plane (NASP) was a three-phase program to develop and demonstrate critical technologies for hypersonic flight and future space launch vehicles. The joint NASA/DoD program was to culminate in a fully reusable, Single-Stage-To-Orbit (SSTO) test vehicle (the X-30) to demonstrate the technologies. Unfortunately, due to budget constraints and technical concerns, phase three (the X-30) was postponed in favor of a restructured test program using expendable vehicles to test NASP technologies. But even the $1.8-billion cost of the restructured program proved too much for Congress, which terminated the program in 1994.[45] Although Congress believes space launch is a critical issue, they are reluctant to fund it because "there is no coherent national strategy to addresses (sic) our future launch system direction."[46] Development of the NASP, and the follow-on operation vehicles it would have spawned, would have provided a low cost, manned access to space for NASA, DoD, and the commercial industry. RECOMMENDATION: The first step in any space strategy should be to restart a NASP-like program, but in parallel with other promising programs.

In 1990, the Ballistic Missile Development Office (BMDO) began working with McDonnell Douglas to build a totally reusable, SSTO vehicle as a cost effective way of launching its "Star Wars" payloads. A sub-scale, sub-orbital vehicle (the DC-X) was built, and it completed three successful flights. Congress appropriated additional money for the program, but split funding and responsibility between the DoD and the Advanced Research Project Agency (ARPA). The future of the program has been in jeopardy, however, because of inter-agency

competition, various space modernization studies currently underway, and uncertainty over the administration's overall space strategy.

Meanwhile, several programs have begun (and ended) over the last decade to develop new, lower cost ELVs. The Advanced Launch System (ALS), the National Launch System (NLS), and the Spacelifter program all promised new families of ELVs, built around common components, advanced processing methods, and greatly simplified operations. But ALS was cancelled in favor of NLS, which was cancelled in favor of Spacelifter. Time and money are spent starting and stopping programs, and more money is spent on studies of (possibly) better ways to do business.

The DoD completed a Space Launch Modernization study in April 1994. Lead by Lt Gen Thomas Moorman, the study panel outlined four options for improving a U.S. launch system, ranging from continuing business as usual to developing a completely reusable launch vehicle costing between $6 and 20 billion. Of particular note is the third option: a brand new ELV which would cost $5-8 billion, or jump to $10-14 billion if it were designed to carry humans. It's significant that the added cost for making ELVs man-rated is only about 5 billion dollars. If the same difference applies to fully reusable launch vehicles, than the cost of making a next-generation launch system man-rated is relatively small and the largest obstacle to increased involvement of man in space is overcome. But the fact is, the nation **will** have a manned launcher - NASA has that responsibility in its charter. Therefore, cost to the *military* for a manned program may be small. And NASA, too, is looking for cheaper access to space.

A year earlier NASA conducted its own "Access to Space" study, and concluded it should transition to a fully reusable, SSTO launch vehicle that would capitalize on technologies developed under the NASP and the DC-X programs. The new vehicle would replace NASA's Shuttle and DoD's Titan IV heavy-lift ELV. Interestingly enough, NASA does not believe it will

have sufficient funding to build an operational vehicle. It "hopes such an operational vehicle would be privately developed, with the Government guaranteeing a certain number of flights per year as an incentive."[47] That's an approach that just may work, given industry's desire to have cheap access to space. As a replacement to the Shuttle, such a vehicle also provides manned access to space, which the military should once again "piggy back" on for its future manned requirements.

Clearly, the incentive exists to build new launch vehicles. The major obstacle to progress is a coherent launch strategy and competing interests. If the administration provides the direction - and commits to it - Congress may be more willing to provide consistent funding. And if the military supports NASA (and its commercial venture) in its need for a manned vehicle, the inter-agency competition will stop blocking progress. But the United States can not afford to make the mistake it made with the Space Shuttle by insisting it be the sole launch vehicle for all DoD missions. The military must, justifiably, argue against a single launch vehicle for the country. Therefore, the best approach is - as usual - a compromise.

RECOMMENDATION: As part of it's new strategy, the United States should <u>commit</u> to building a next generation family of fully reusable launch vehicles, based as much as possible on NASP technology. It should include a man-rated core element, plus an unmanned capability to allow launch of heavier payloads.[r] Such a system, however, could not be available for at least a decade - and the U.S. cannot afford to wait that long in today's burgeoning space economy. Therefore, DoD and NASA should also support commercial development of a near-term ELV (or reusable vehicle) based on the DC-X technology. NASA's approach of providing seed money and a guarantee for a number of launches may work. A man-rated ELV is not required, since the

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[r] This is essentially what NASA proposed years ago when it conceived of an unmanned cargo pod with engines, replacing the orbiter and mounted on the existing external tank and solid rocket boosters.

current Space Shuttle provides needed access. Since relations with Russia have improved, their Soyuz craft provides sufficient access capability to MIR and the International Space Station in the event another accident grounds the Shuttle. And since such accidents are a part of space travel - as they are for life in general - a prudent strategy should help minimize the risk and impact of occurrence. Again, using the military more actively can provide benefits.

Until the "Orient Express" former President Reagan envisioned when he commissioned the NASP program becomes reality, space flight will remain inherently dangerous. But any next-generation manned space lifter, using NASP technology or not, will be dangerous to fly, particularly during development and testing. The military (through its contractors) has a great deal of experience in developing and operating experimental and operational aircraft, and should be deeply involved in developing the next manned space vehicles. By using proven techniques to reduce risk during development, the military can help build a safer and more survivable vehicle. Ejection from high-speed aircraft, for example, is a problem the military faces each time it designs an airplane, and it has developed several methods and techniques to increase chances of survival. Capsule ejection, such as on the FB-111, may be applicable - particularly if the capsule is built as a separate module for a manned/unmanned launcher. In any event, military experience could be beneficial.

Using military test pilots and crews has another benefit, though a somewhat morbid one. In the public eye, military crews are more expendable than civilians. Military soldiers, sailors, and airmen lose their lives every day in the line of duty. The public takes note and moves on. But civilian loss of life, particularly in high profile events such as the *Challenger* tragedy, is much more likely to elicit shock, sympathy, and a demand for increased, often excessive safety standards. It took 32 months to fly another shuttle after the loss of *Challenger*. Certainly the delay was not due entirely to the presence of civilians on board, but military aircraft crash almost

weekly, yet operations generally continue unabated. The X-15 research project, upon which much of the Shuttle's technology was developed, continued almost non-stop for 9 years, despite accidents and the deaths of 2 test pilots.[s] In planning the next generation manned spacecraft it would be prudent to consider the consequences of a catastrophic accident. By using military risk-reduction techniques and military crews, the potential delay caused by accidents might be minimized.[t] This is not to suggest civilians should never fly in space. But with military crews taking the initial risks while "pushing the envelope," routine civilian and commercial space flight will come sooner.

The commercial airline industry provides a parallel. It developed mainly as a result of military requirements and military pilots - many of whom died testing new technologies and techniques. The ones who survived brought their experience to bare on new developments and new requirements. Using "lessons learned" is an essential part of any continuing program, whether operational or experimental. Yet it is something the military has done very poorly with regard to manned space operations. It must be addressed in any space strategy if the military is to develop its mission in space.

The military has wasted an extraordinarily valuable resource in expanding its space mission - the astronauts themselves. Since the first manned space flight, only a handful of astronauts have returned to active military service after a flight.[u] While they retain their military rank, they almost invariably continue to work directly for NASA in some capacity, then retire

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[s] Major Michael Adams, USAF, was killed when his X-15 went into an uncontrollable spin. John B. "Jack" McKay died as a result of complications from severe injuries received when his X-15 broke apart on landing.

[t] The first four Shuttle flights flew in this manner. The two man military (or former military) crew flew with ejection seats. Only after the Shuttle was declared "operational" were the ejection seats removed.

[u] Military astronauts are essentially loaned to NASA for the duration of their duties, an often undetermined period of time. While they are still technically working for the military, they report strictly through the NASA chain of command.

and transfer to civil service or industry when eligible. The few who have returned to military duty have mostly gone into jobs unrelated to their space flight experience, and fewer still have been promoted to flag rank. Much of this is due to the perception that the military no longer wants them - or has a need for them.[48] This perception can easily be changed, and must be if the military wants to take maximum advantage of space.

RECOMMENDATION: The military must establish a clear, progressive career path for it's members involved in space operations, including those who fly in space. Such a path was partially developed in the initial days of Shuttle operations[v]. It should recall those astronauts on loan to NASA who have completed one or two space flights, and put them in positions of responsibility within U.S. Space Command or one of the service's space development units. At the same time, it should regain control of those astronauts still serving with NASA. Establishing a joint, wing-level unit under USSPACECOM to which astronauts of all services are assigned would allow the military to continue loaning astronauts to NASA while permitting better integration of astronauts - and lessons learned - into present and future military operations. As those men and women bring their experience back to military space operations, they will undoubtedly bring ideas for new applications of military man in space. And new applications for the military would lead to increased use of space - both manned and unmanned - resulting in lower cost access, commercial spin-offs, and increased economic benefits. It's just one more way the military, and military man in space, can help satisfy the nation's goals in space.

In summary, a national space strategy benefiting from military man in space - and from which the military can benefit - is basically in place. The current Shuttle and a new ELV will

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[v] The Air Force created unique Air Force Specialty Codes (AFSCs) and Special Experience Identifiers (SEIs) to assign to astronauts, MSEs and Shuttle specialists. The plan was to track them within the Air Force Personnel System, and manage their careers just as it managed pilots.

satisfy near-term requirements while developing a man-rated, single-stage-to-orbit vehicle family to meet the increasing needs of the future. Pulling the military astronauts back into dedicated, integrated space service in the military will spur development of manned applications and systems to make them practical. That, in turn, will lower risk for the commercial sector, providing increased business opportunities and further expanding the space industrial base. The framework for a successful strategy is already in place; the missing ingredients are direction and commitment. Until this nation picks the path for it's space efforts, and commits the resources to travel it, we will continue to study the problem, reach the same conclusions, and watch other countries enjoy the economic and military benefits of increased space exploitation.

CONCLUSIONS

Space is already a critical element of our national security, and it's importance continues to grow. It is integral to our economic and military power, and therefore to our political prestige. Our existing national security strategy establishes that relationship clearly and persuasively. Various studies and programs underway address the major obstacles to our space exploitation effort, particularly the high cost of access to space. Military doctrine claims space as a key battleground of the future, and calls for conducting "the full spectrum of military space capabilities." Yet despite the importance we place on space and the military doctrine and policy calling for controlling and exploiting space, we have so far opted to operate in space without a consistent plan to use the military's most valuable asset: man. There can be little doubt of the creativity, flexibility, adaptability, and intellect man can bring to space - as he brings to any endeavor. History is filled with space missions made possible only because man was on scene, using experience, wisdom, and judgement to satisfy mission goals. Although military man is clearly not suited for all space missions, he is ideally suited for others - some in existence, others which easily could be. As in every other military field, man's presence brings important and often unanticipated benefits to the work place and battlefield. Our military services operate successfully in support of national objectives precisely because trained men and women operate in the harsh environments on land, at sea, and in the air. It has been that way throughout history. By what change in circumstance do we argue space operations can be different? True, technology allows us to eliminate man in some applications, but it augments man's ability in others. Technology made sea power, air power, and now space power possible - but it has not

obviated man's presence when we must still conduct "the full spectrum of military space capabilities."

Our National Security Strategy must take advantage of the full political, economic, and military power of this nation to be successful. That means soldiers, sailors and airmen able to operate in every region of the world critical to national security, whether it be on land, at sea, in the air, or in space. A strategy built on anything less is incomplete and shortsighted. Our existing strategy is a strong framework, but it needs focus and commitment regarding space exploitation to make it effective. Much of that is taking place in the military and commercial space community already, but minor enhancements can bring it about faster and cheaper by incorporating man's unique capabilities into the infrastructure. Military man in space comes with a cost, but it is a small addition to the cost of the inevitable next-generation space vehicles. And while it brings increased risk to the individual space traveler, military manned space flight reduces risk to the development effort in general, and increases the chances for non-military manned flight and commercial spin-offs. But most importantly, it provides full capability to conduct the military operations in space which may become increasingly important to protect our national interests in space, and in every part of the globe space assets effect. Can we really afford to forgo the lessons of history, and needlessly limit ourselves by not including our most valuable assets in our potential battlefields? Is *that* a risk we can afford to take? I think not.

> I feel an undefinable but very real sense of urgency - a basic premonition that in some future period we are going to look back and wonder why we were so slow to comprehend the value of man in space.[49]
>
> - General Jerome F. O'Malley, USAF

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16. Originally, astronaut George "Pinky" Nelson was to capture the satellite with a special-purpose grappling fixture mounted to the Manned Maneuvering Unit, the "Buck Rogers Back Pack" that let astronauts fly un-tethered from the Shuttle's payload bay. Nelson performed the rendezvous and grappling maneuver perfectly; however, a small protruding metal piece on the satellite, unaccounted for in the grappling fixture's design, prevented the fixture from mating with the satellite. Several attempts failed, and imparted an unwanted tumbling motion to the "Solar Max" satellite. The next day, after

ground controllers stabilized the tumbling spacecraft, the crew made one last attempt to capture it. Capt Crippen maneuvered the shuttle into RMS range, and, in a demonstration of extraordinary skill, fellow astronaut "T.J." Hart captured it with the RMS. The event was particularly noteworthy because Crippen, as mission commander, made several key decisions in the final moments of the operation while out of contact with mission control in Houston. Except for his on-scene judgement, the mission would have failed. (Data taken from Space Shuttle Highlights I, a series of NASA video excerpts collected and distributed by Starbound Enterprises, Hawthorne Ca.)

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